08-168715 Jul. 2, 1996 L10: 2 of 22

ROTARY COATING DEVICE AND METHOD THEREOF

INVENTOR: MASAHIRO MIMASAKA
ASSIGNEE: DAINIPPON SCREEN MFG CO LTD
APPL NO: 06-313335
DATE FILED: Dec. 16, 1994
PATENT ABSTRACTS OF JAPAN
ABS GRP NO:
ABS VOL NO:
ABS PUB DATE:
INT-CL: B05C 11/08; B05D 1/40; H01L 21/027

ABSTRACT:

PURPOSE: To keep the discharge of a treating liquid to an irreducible minimum to average the liquid quantity on a substrate.

CONSTITUTION: A circular **wafer** 11 is attracted to a low speed rotation chuck 12 over the whole surface and is made flat, and while a treating liquid is discharged onto the surface of the **wafer** from a **slit nozzle** 14 whose length is almost equal to the diameter of the **wafer** 11, the **wafer** 11 is rotated at a low speed. After that, the **wafer** 11 is conveyed to a high speed rotation chuck 16 to rotate it at high speed to shake off excess treating liquid by centrifugal force, permitting a desired film thickness to be obtained. Therefore, with the **slit nozzle** 14 being brought close to the **wafer** 11 to the utmost, the treating liquid is fed to reduce the quantity of the treating liquid to be used.

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（A）　(11)特許出願公開番号

特開平8－168715

(43)公開日　平成８年(1996)７月２日

(51)Int.Cl.⁶	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｂ０５Ｃ　11/08				
Ｂ０５Ｄ　1/40		Ａ　7415－4Ｆ		
Ｈ０１Ｌ　21/027				
			Ｈ０１Ｌ　21/30　５６４　Ｃ	
			５６４　Ｄ	

審査請求　未請求　請求項の数２　ＯＬ　（全８頁）

(21)出願番号　特願平6－313335

(22)出願日　平成６年(1994)12月16日

(71)出願人　000207551
大日本スクリーン製造株式会社
京都府京都市上京区堀川通寺之内上る４丁目天神北町１番地の１

(72)発明者　美作　昌宏
京都市伏見区羽束師古川町322番地　大日本スクリーン製造株式会社洛西工場内

(74)代理人　弁理士　吉田　茂明　（外２名）

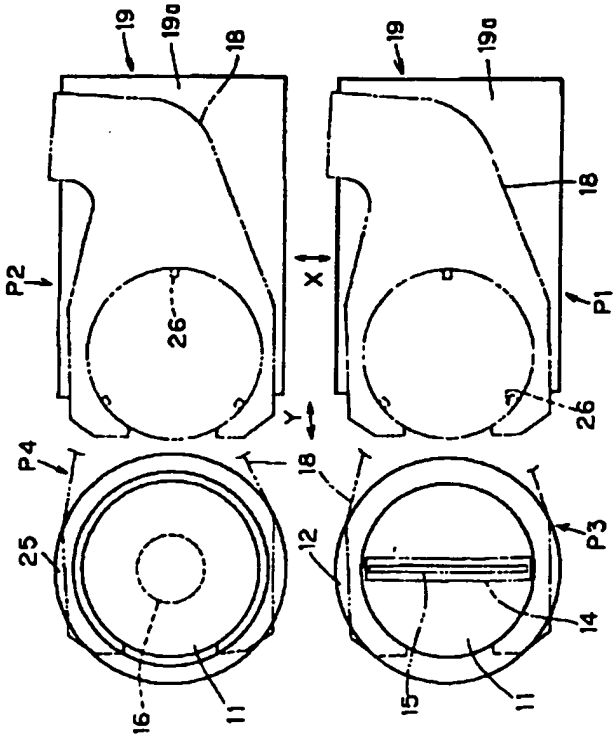
(54)【発明の名称】　回転式塗布装置および回転式塗布方法

(57)【要約】

【目的】　処理液の吐出量を必要最小限にし、基板上での液量を平準化する。

【構成】　低速回転用チャック１２に円形ウェハ１１を全面吸着して平坦化し、ウェハ１１の直径に略等しい長さのスリットノズル１４からウェハ表面に処理液を吐出しつつ、ウェハ１１を低速回転させる。その後ウェハ１１を高速回転用チャック１６へ搬送し、ウェハ１１を高速回転させて、余剰の処理液を遠心力にて振り切って所望の膜厚とする。

【効果】　スリットノズル１４を可及的にウェハ１１へ近接して処理液を供給でき、処理液の使用量を低減できる。



【特許請求の範囲】

【請求項１】　略円形の基板の表面に処理液を供給して基板を回転させることにより塗布する回転式塗布装置において、

前記基板の裏面を略全面吸着して支持する第１の基板支持手段と、

前記第１の基板支持手段に支持された前記基板の表面に対して、その直径に略等しいかまたは若干短い長さの線状に処理液を吐出する処理液供給手段と、

前記第１の基板支持手段および前記処理液供給手段の少なくとも一方を他方に対して所定の低速度で回転させる第１の回転手段と、

前記基板の裏面の中央部のみを吸着して支持する第２の基板支持手段と、

前記基板上の処理液を遠心力にて平滑化するよう前記第２の基板支持手段を所定の高速度で回転する第２の回転手段と前記処理液供給手段での処理液吐出後に前記第１の基板支持手段から前記第２の基板支持手段へ前記基板を搬送する搬送手段とを備える回転式塗布装置。

【請求項２】　略円形の基板の表面に処理液を供給して基板を回転させることにより塗布する回転式塗布方法において、

第１の基板支持手段に前記基板の裏面を略全面吸着した状態で、処理液供給手段により当該基板の表面に当該基板の直径にそって線状に処理液を吐出しつつ、当該基板および前記処理液供給手段の少なくとも一方を他方に対して所定の低速度で回転させる処理液吐出工程と、

前記処理液供給手段からの前記処理液の吐出完了後に、前記基板を前記第１の基板支持手段から第２の基板支持手段へ搬送する搬送工程と、

前記第２の基板支持手段により基板の裏面の中央部のみを吸着して支持した状態で、前記基板上の処理液を遠心力にて平滑化するよう前記第２の基板支持手段を所定の高速度で回転する高速回転工程とを備える回転式塗布方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、例えばＩＣ、ＬＳＩ、液晶表示装置等の電子部品の製造工程における微細パターンの形成工程において、シリコンウエハに代表される半導体基板、あるいは誘電体、金属、絶縁体等の基板に、フォトレジスト液等を供給して回転させることにより塗布するスピンコータ等の回転式塗布装置および回転式塗布方法に関する。

【０００２】

【従来の技術】

〔第１の従来例〕第１の従来例の回転式塗布装置は、図６の如く、水平に支持されたウェハ１の中心部に、ウェハ１を静止ないし図７のように低速回転させた状態でノズル２からレジスト液３（フォトレジスト）を吐出し、

その後、図８のようにウェハ１を高速回転させることにより、レジスト液３を基板表面に塗布するものである。なお、図６、図７および図８中の４はウェハ１の中央部を吸着固定して回転する回転支持部、図６中の５はチャンバーである。

【０００３】〔第２の従来例〕第２の従来例の回転式塗布装置として、例えば特開昭５８－１７０５６５号公報で開示されているレジスト塗布装置が存在する。図９は、この装置の構造を説明する図である。第２の従来例の回転式塗布装置では、円形のウェハ１を支持台の上に水平に載置してその中央部を吸着固定し、ウェハ１を支持台ごと中心軸（鉛直軸）を中心に低速で回転させつつ、このウェハ１の表面上に、スリット状の吐出口６ａが形成されたノズル６からレジスト液３（フォトレジスト）を帯状に滴下する。次に、レジスト液３の滴下を終了してから、ウェハ１を支持台ごと中心軸（鉛直軸）を中心に高速で回転させ、遠心力によりウェハ１の表面にレジスト液３を広げて薄膜を形成する。

【０００４】

【発明が解決しようとする課題】

〔第１の従来例の課題〕第１の従来例では、ウェハ１を比較的低速で回転させてウェハ１の中心部に吐出されたレジスト液３をその全面に塗り広げ、しかる後に、ウェハ１を比較的高速で回転させて余剰のレジスト液３を振り切って所望の厚みのレジスト液３の薄膜を形成する。この装置によれば、塗布された薄膜は、比較的良好な膜厚均一性が得られる。しかしながらこの装置では、レジスト液３をウェハ１の全面に回転により塗り広げるために、比較的多量のレジスト液３を供給しなければならず、その塗り広げる段階でもはやむだになるレジスト液３が生じ、そこからさらに余剰のレジスト液３を振り切るので、有効に利用されるレジスト液３の割合はごく少ないものとなる。この場合、レジスト液３を所定の厚さ（例えば数μｍ）で塗布するのに必要とされるレジスト量（高速回転後にウェハ１に残留するレジスト量）の数十倍のレジスト液３をノズルから供給する必要がある。すなわち、ノズルから供給されたレジスト液３の９０％以上は、高速回転によりウェハ１の周囲に飛散されるため、その分の材料が無駄に使用されることになる。

【０００５】〔第２の従来例の課題〕第２の従来例においては、ウェハ１の表面に供給されたレジスト液３は、すでにほぼその全面に塗り広げられた状態であるので、レジスト液３をウェハ１の全面に塗り広げる段階でのレジスト液３のむだは比較的少なくできる。そして、この従来例において、レジスト液３の使用量をさらに低減するためには、レジスト液３をウェハ１に供給する段階で、できるだけ最終的に所望する膜厚に近い薄さ（例えば数十μｍ）でレジスト液３を供給することが望ましい。そのためには、ウェハ１とノズル６のスリット状の吐出口６ａとを可及的に近接（例えば数十μｍ）させる

必要がある。この場合、ウェハ1とノズル6のスリット状の吐出口6aとの離間距離をほぼ一定に短く保つためには、ウェハ1の平坦性を確保する必要がある。しかしながら、従来例の回転式塗布装置では、ウェハ1の支持台上での吸着固定を中央部のみで行っていたため、それまでに施された熱処理の影響でウェハ1が反ったり自重により撓んだりした場合に、ウェハ1の平坦性を確保するのが困難であった。具体的には、かかるウェハ1の反りや撓みは最大で数百μm（例えば、直径8インチのウェハに対する反りは150μm）にも達するため、数十μm程度までノズル6を近接させるのは困難となる。かかる状況下で、ウェハ1上にレジスト液3を満遍なく吐出するためには、レジスト液3の吐出量を必要最低限の量よりかなり多めに設定する必要があり、材料コストの増大を招いていた。

【0006】本発明は、上記課題に鑑み、必要な処理液の量をさらに低減することができ、かつ基板上での膜厚の均一性が良好な回転式塗布装置および回転式塗布方法の提供を目的とする。

【0007】

【課題を解決するための手段】本発明の請求項1に係る課題解決手段は、略円形の基板の表面に処理液を供給して基板を回転させることにより塗布する回転式塗布装置において、前記基板の裏面を略全面吸着して支持する第1の基板支持手段と、前記第1の基板支持手段に支持された前記基板の表面に対して、その直径に略等しいかまたは若干短い長さの線状に処理液を吐出する処理液供給手段と、前記第1の基板支持手段および前記処理液供給手段の少なくとも一方を他方に対して所定の低速度で回転させる第1の回転手段と、前記基板の裏面の中央部のみを吸着して支持する第2の基板支持手段と、前記基板上の処理液を遠心力にて平滑化するよう前記第2の基板支持手段を所定の高速度で回転する第2の回転手段と前記処理液供給手段での処理液吐出後に前記第1の基板支持手段から前記第2の基板支持手段へ前記基板を搬送する搬送手段とを備える。

【0008】本発明の請求項2に係る課題解決手段は、略円形の基板の表面に処理液を供給して基板を回転させることにより塗布する回転式塗布方法において、第1の基板支持手段に前記基板の裏面を略全面吸着した状態で、処理液供給手段により当該基板の表面に当該基板の直径にそって線状に処理液を吐出しつつ、当該基板および前記処理液供給手段の少なくとも一方を他方に対して所定の低速度で回転させる処理液吐出工程と、前記処理液供給手段からの前記処理液の吐出完了後に、前記基板を前記第1の基板支持手段から第2の基板支持手段へ搬送する搬送工程と、前記第2の基板支持手段により基板の裏面の中央部のみを吸着して支持した状態で、前記基板上の処理液を遠心力にて平滑化するよう前記第2の基板支持手段を所定の高速度で回転する高速回転工程とを備える。

【0009】

【作用】本発明請求項1に係る回転式塗布装置および請求項2に係る回転式塗布方法では、第1の基板支持手段により基板の裏面を略全面吸着して基板を平坦に支持して低速回転させ、この状態で処理液供給手段から基板の表面にその直径にそって線状に処理液を吐出して、基板表面ほぼ全面に処理液が供給される。仮に基板に反りや撓みが発生した場合でも、基板の裏面を略全面吸着しているので、その反りや撓みの影響を軽減でき、処理液供給手段を基板に可及的に近接させ得る。そのため、処理液が比較的薄く均一な状態で基板表面に供給され、処理液の吐出量が低減される。

【0010】処理液を基板に供給した後、第2の基板支持手段へ基板を搬送し、処理液の振り切り時においては、基板の裏面の中央部のみを吸着して支持して高速回転させるので、処理液が基板支持手段と基板との間に毛細管現象で入り込んだり、処理液のミスト（霧）が基板支持手段に付着したりして基板支持手段が汚染されることが少ない。

【0011】

【実施例】

〔第1の実施例〕

＜構成＞図1は本発明の第1の実施例の回転式塗布装置を示す概略図、図2は同じく本実施例の回転式塗布装置を示す平面図である。該回転式塗布装置は、図1および図2の如く、回転する半導体の円形ウェハ11（基板）の表面にフォトレジスト（処理液）を供給して塗布し、円形ウェハ11の表面にフォトレジストの薄膜を形成するものである。

【0012】ここで、図1，図2中、12は円形ウェハ11の表面を上向きにしてその裏面を全面吸着して支持する第1のスピンチャック（第1の基板支持手段：全面吸着ステージ）、13は前記第1のスピンチャック12を鉛直軸周りで所定の低速度で回転する第1のモータ（第1の回転手段）、14は前記第1のスピンチャック12に支持されて低速回転する円形ウェハ11の表面に向けてフォトレジストを供給するスリットノズル14（処理液供給手段）、15は前記スリットノズル14の下面に形成されたスリット状の処理液吐出口（以下、単にスリットと称す）、16は第1のスピンチャック12の側方に並設され、前記円形ウェハ11の中央部のみを吸着して支持する第2のスピンチャック（第2の基板支持手段：スピン処理部）、17は前記第2のスピンチャック16を鉛直軸周りで所定の高速度で回転する第2のモータ17（第2の回転手段）、18は前記スリットノズル14での処理液吐出後に前記第1のスピンチャック12から前記第2のスピンチャック16へ前記円形ウェハ11を搬送する搬送ロボット19（搬送手段）の搬送アームである。

【００１３】前記第１のスピンチャック１２は、支持する円形ウェハ１１の反りや撓みを防止してその平坦性を精度良く確保するため、円形ウェハ１１よりも大径に形成された全面真空吸着方式のものが採用される。ここで、かかる全面真空吸着方式のチャックの場合、円形ウェハ１１の裏面のほぼ全体が第１のスピンチャック１２に直接触れることになるため、仮にこの第１のスピンチャック１２を高速回転用としても使用した場合には、高速回転にて処理液を振り切る際に、処理液のミスト（霧）がスピンチャック１２に付着したり、チャック上面とウェハ裏面の間に毛細管現象等にて回り込み、スピンチャック自体が汚染されたり、該ミストが円形ウェハ１１の裏面全体に付着してこれを汚染するおそれがある。かかる事態は製品管理上極めて好ましくない。そこで、該第１のスピンチャック１２は、前記スリットノズル１４にて処理液を吐出する際（低速回転時）のみに限定して使用される。

【００１４】なお、前記円形ウェハ１１の搬送時には、前記搬送アーム１８を前記円形ウェハ１１の裏面に回し込んで支持しながら搬送する必要があるが、該第１のスピンチャック１２は前記円形ウェハ１１の裏面全部を密着して覆うため、このままの状態では搬送アーム１８を前記円形ウェハ１１の裏面に回し込むことができない。すなわち、搬送アーム１８を前記円形ウェハ１１の裏面に回し込むためには、円形ウェハ１１を上方へ浮かせて円形ウェハ１１の裏面を前記第１のスピンチャック１２から離間させる必要がある。そこで、図１の如く、円形ウェハ１１を第１のスピンチャック１２の上面から上昇させるウェハ上昇装置２２を設けている。すなわち、第１のスピンチャック１２のウェハ支持領域の数カ所（３カ所以上）に貫通孔２０を形成し、さらに、該各貫通孔２０に前記ウェハ上昇装置２２の支持棒２１を挿入して（図１中の点線部分参照）前記円形ウェハ１１を支持し、当該円形ウェハ１１を上昇させている。該ウェハ上昇装置２２は、例えばモータ、ピニオンおよびラック等（図示せず）を備え、前記搬送アーム１８の動作と連動して駆動制御される。

【００１５】前記第１のモータ１３は、図１の如く、前記スリットノズル１４にて処理液を吐出する際に前記第１のスピンチャック１２を前記スリットノズル１４に対して鉛直軸を中心として低速回転させるもので、回転速度は１０～５０ｒｐｍ程度、望ましくは２０～３０ｒｐｍ程度とされる。

【００１６】前記スリットノズル１４は、図示しない所定の支持体によって水平姿勢で、且つ昇降可能に支持される。該スリットノズル１４のスリット１５の長さ（以下、ノズル長と略す）は、図３（ａ）の如く、処理対象となる円形ウェハ１１の直径に略等しく設定されている。そして、かかるスリットノズル１４は、そのスリット１５の中央が、第１のスピンチャック１２に支持された円形ウェハ１１の回転中心の上方に位置するように配置されており、前記第１のモータ１３で低速回転しながら円形ウェハ１１のほぼ直径に相当する領域へ線状にフォトレジストを吐出することで、円形ウェハ１１のほぼ全面領域へフォトレジストを吐出する。ただし、実際には、ノズル長は当該円形ウェハ１１の直径より若干短く設定されていることが望ましい。このように、ノズル長を直径より若干短くするのは、円形ウェハ１１の周縁部にはレジストを塗布する必要がないからであり、これにより円形ウェハ１１の搬送手段がレジストで汚染されるのを防止できる。そして、図１の如く、該スリットノズル１４が下降されて前記第１のスピンチャック１２に対して所定の高さ位置に配置されることで、当該スリットノズル１４のスリット１５と円形ウェハ１１の表面との間の離間距離（δ）は例えば３０～１００μｍ程度に設定される。これにより、スリットノズル１４による円形ウェハ１１へのフォトレジストの供給は、供給後のフォトレジストの厚みがその離間距離（δ）とほぼ同程度（約３０～１００μｍ程度）を目標として行われる。そのためのフォトレジストの必要供給集まる量は、直径８インチの円形ウェハ１１の場合で約１～３ｍｌ程度である。

【００１７】なお、前述の第１スピンチャック１２の回転は、スリットノズル１４のスリット１５を円形ウェハ１１のほぼ全面を走査させ、円形ウェハ１１のほぼ全面にフォトレジストを広げて供給するためであり、その回転数は供給されたフォトレジストが遠心力で円形ウェハ１１の縁から外側へ流れ出たりすることのない程度の低速に設定される。

【００１８】前記第２のスピンチャック１６は、振り切りを目的として高速回転されるもので、処理液を振り切る際に処理液のミスト（霧）がチャック上面とウェハ裏面の間に毛細管現象等にて回り込む事態を可及的に低減するよう、円形ウェハ１１との接触面積を可及的に小に設定している。すなわち、該第２のスピンチャック１６は、図１および図２の如く、中央部のみで円形ウェハ１１を吸着支持するよう構成されている。該第２のスピンチャック１６は、処理液の振り切り時に排液を排出するためのドレン用のチャンバー２５内に収容されている。

【００１９】前記第２のモータ１７は、図１の如く、鉛直軸を中心として高速回転することで、前記円形ウェハ１１の表面に吐出された処理液を遠心力にて振り切って均すことで該処理液の膜厚を所望の寸法（目標寸法は例えば１μｍ程度）に平滑化ないしは平準化するもので、回転速度は例えば２，０００～６，０００ｒｐｍ程度、望ましくは３，０００～５，０００ｒｐｍ程度とされる。

【００２０】なお、図示はしていないが、第１のスピンチャック１２および第２のスピンチャック１６には、円形ウエハ１１を吸着支持するための吸気通路が形成され

ている。

【００２１】前記搬送ロボット１９は、図４に示す如く、その基台部１９ａに搬送アーム１８を取り付けて構成される。基台部１９ａは搬送アーム１８を進退させる駆動機構を有しており、搬送アーム１８は基台部１９ａに対して水平（Ｙ）方向に進退可能に取り付けられている。また、基台部１９ａは、水平面内において（Ｙ）方向と直交する（Ｘ）方向に移動可能な移動機構を有しており、図２に示す如く、第１のスピンチャック１２と第２のスピンチャック１６とに沿って移動するように設けられる。これにより搬送アーム１８は、図２の平面図に示す如く、前記第１のスピンチャック１２に隣接する搬送位置Ｐ１と前記第２のスピンチャック１６に隣接する搬送位置Ｐ２とを結ぶ水平（Ｘ）方向に移動可能であり、且つ搬送位置Ｐ１と受渡位置Ｐ３、および搬送位置Ｐ２と受渡位置Ｐ４とを結ぶ水平（Ｙ）方向に移動可能となっている。搬送ロボット１９は、かかる移動により、図示しないホットプレート、クールプレート等の熱処理部、あるいはウエハ供給部（インデクサ）や他の処理部等と、第１のスピンチャック１２、第２のスピンチャック１６との間で、円形ウェハ１１を搬送して供給・搬出する動作を行う。なお、図２中の２６は前記搬送アーム１８において前記円形ウェハ１１を載置支持するための支持爪である。

【００２２】＜動作＞上記構成の回転式塗布装置の動作と、その装置を使用した本発明の方法を図５に従って説明する。まず搬送ロボット１９にて円形ウェハ１１を熱処理等の図示しない前処理部から前記第１のスピンチャック１２（全面吸着ステージ）へ供給する（ステップＳ１）。そして、円形ウェハ１１の裏面を第１のスピンチャック１２に全面真空吸着させて円形ウェハ１１の反りや撓みを補正し（ステップＳ２）、円形ウェハ１１の表面に円形ウェハ１１の直径をほぼカバーするスリットノズル１４を近接対向して配置する（ステップＳ３）。この際、図１の如く、円形ウェハ１１とノズルの間の離間距離（δ）を３０～１００μｍ程度に小さく設定しておく。

【００２３】次に、円形ウェハ１１を低速回転させ（ステップＳ４）、スリットノズル１４からその円形ウェハ１１の直径にそって線状にフォトレジストを吐出し（処理液吐出工程：ステップＳ５）、円形ウェハ１１の表面のほぼ全面にフォトレジストを塗布する。この際の回転速度は、１０～５０ｒｐｍ程度、望ましくは、２０～３０ｒｐｍ程度である。この際、図１の如く、円形ウェハ１１とノズルの間の離間距離（δ）を３０～１００μｍ程度に小さく設定しているため、処理液を３０～１００μｍ程度に薄く塗布でき、且つその塗布むらを大幅に低減できる。なお、スリットノズル１４のノズル長を直径より若干短く設定しているので、円形ウェハ１１の周縁部にレジストを塗布する事態を防止でき、円形ウェハ１

１の搬送ロボット１９の搬送アーム１８がレジストで汚染されるのを防止できる。ここでは、円形ウェハ１１の直径にそって線状にフォトレジストを吐出するので、フォトレジストを吐出しながら円形ウェハ１１を半回転させれば円形ウェハ１１の全面にレジストを塗布できる（ステップＳ６）。円形ウェハ１１が半回転したところでその回転とフォトレジストの吐出を停止する。なお、この段階では、塗布したフォトレジストの厚みの均一性はさほど必要ではない。

【００２４】このように、第１のスピンチャック１２にて円形ウェハ１１を全面吸着支持して円形ウェハ１１の平坦性を確保することで、円形ウェハ１１とノズルのスリットとを可及的に近接（数十μｍ）させることができ、故にフォトレジストの吐出量を可及的に低減しつつ、ウェハ上での液量を厚さ数μｍに平準化することができる。

【００２５】その後、スリットノズル１４を上昇して退避させ、搬送ロボット１９にて円形ウェハ１１を第１のスピンチャック１２に並設される第２のスピンチャック１６（スピン処理部）に移載し（搬送工程：ステップＳ７）、高速回転させて所望の厚みで且つ均一な膜厚のレジスト膜を得る（高速回転工程：ステップＳ８）。回転速度は２，０００～６，０００ｒｐｍ程度、望ましくは３，０００～５，０００ｒｐｍ程度である。ここでは、高速回転することにより、数μｍ程度で膜厚均一性に優れたレジスト膜が形成される。しかる後、搬送ロボット１９にて処理後の円形ウェハ１１を後工程の処理部へ向けて搬出する。

【００２６】以上のように、低速回転時に全面吸着にて円形ウェハ１１を極めて平坦に支持しているので、スリットノズル１４を可及的に円形ウェハ１１の表面に近接できる。したがって、スリットノズル１４からの処理液の吐出量を最小限に設定しても、円形ウェハ１１の表面全部に処理液をむらなく塗布できる。

【００２７】また、全面吸着用の第１のスピンチャック１２を低速回転時のみ使用し、高速回転時は第２のスピンチャック１６にて中央部のみで吸着しているので、処理液を振り切る際にチャックとウェハとの接触面積を小とすることで、処理液のミスト（霧）がチャック上面と円形ウェハ１１の裏面の間に毛細管現象等にて回り込む事態を低減することができる。

【００２８】なお、スリットノズルとして、基板の半径に略等しいかまたは若干短い長さの線状に処理液を吐出するものを用いることもできる。その場合、図３（ｂ）に示すように基板の中心からその半径に沿って処理液を吐出するようにスリットノズルを配置し、そして、処理液吐出後は、基板を第２の基板支持手段へ搬送して高速回転させて余剰の処理液を振り切る動作を行う。かかる構成でも、処理液の使用量を低減でき、また基板や基板支持手段の汚染も防止し得る。しかし、この場合には、

基板の全面へスリットノズルから処理液を供給するためには基板とスリットノズルとを相対的に１回転させなければならず、処理液の供給に比較的長時間を要し、初期に吐出した処理液と後期に吐出した処理液とでその処理液の溶剤成分の揮発状態などで差が生じ、そのため、高速回転による余剰処理液振り切り後の膜厚が均一にならないことが考えられる。それに比べて、処理液の供給が半回転ですむ図３（ａ）の場合には、比較的短時間で処理液の供給が完了するので、かかる不都合は生じない。

【００２９】〔変形例〕

（１）　上記実施例では、基板として円形ウェハを対象とした場合について説明したが、本発明はこれに限られることはなく、例えばオリエンテーションフラットやノッチが形成された半導体ウェハ等の略円形の基板であってもよい。例えばオリエンテーションフラットが形成された半導体ウェハの場合には、スリットノズル１４のスリット１５は、吐出したフォトレジストがオリエンテーションフラットにかからないように、そのスリット１５の大きさを若干小さくすることが望ましい。これは、第１のスピンチャック１２等にフォトレジストが付着するのを防止するためである。また、処理液供給手段としては、上記実施例のようなスリットを使用したものに限らず、例えば多数の小さな処理液吐出口を直線状に並べて実質的に基板の直径にそって線状にフォトレジストを吐出するものであってもよい。

【００３０】（２）　上記実施例では、スリットノズル１４を固定して第１のスピンチャック１２のみを回転させていたが、第１のスピンチャック１２を固定してスリットノズル１４のみを回転させてもよく、さらに、第１のスピンチャック１２およびスリットノズル１４の両方を互いに逆方向となるよう回転させてもよい。

【００３１】

【発明の効果】本発明請求項１および請求項２によると、低速回転時に全面吸着にて基板を平坦に支持し、かかる状態で処理液供給手段から処理液を吐出するよう構成しているので、基板に反りや撓みが発生した場合でも、全面吸着にて基板を平坦化した後に、処理液供給手段を可及的に基板の表面に可及的に近接することができる。したがって、液吐出を無駄なく行うことができ、処理液供給手段からの処理液の吐出量を低減でき、且つ、基板の表面全部に処理液をむらなく塗布できる。

【００３２】また、全面吸着用の第１の基板支持手段を低速回転時のみ使用し、高速回転時は第２の基板支持手段にて中央部のみで吸着するよう構成しているので、処理液を振り切る際に基板支持手段と基板との接触面積を小にし、処理液のミスト（霧）が基板支持手段上面と基板の裏面の間に毛細管現象等にて回り込む事態を低減し、基板支持手段や基板の汚染を防止することができる。

【図面の簡単な説明】

【図１】本発明の第１の実施例の回転式塗布装置の概略を示す模式図である。

【図２】本発明の第１の実施例の回転式塗布装置を示す平面図である。

【図３】回転式塗布装置における円形ウェハおよびスリットノズルを示す斜視図である。

【図４】本発明の第１の実施例の回転式塗布装置における搬送ロボットを示す図である。

【図５】本発明の第１の実施例の回転式塗布装置の動作を示すフローチャートである。

【図６】第１の従来例の回転式塗布装置の概略を示す断面図である。

【図７】第１の従来例の回転式塗布装置の処理液吐出動作を示す図である。

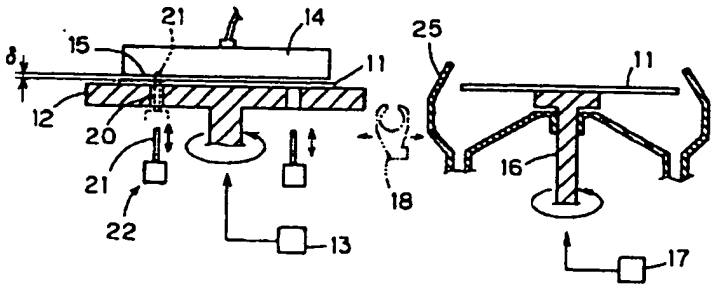
【図８】第１の従来例の回転式塗布装置の処理液飛散動作を示す図である。

【図９】第２の従来例の回転式塗布装置の概略を示す図である。

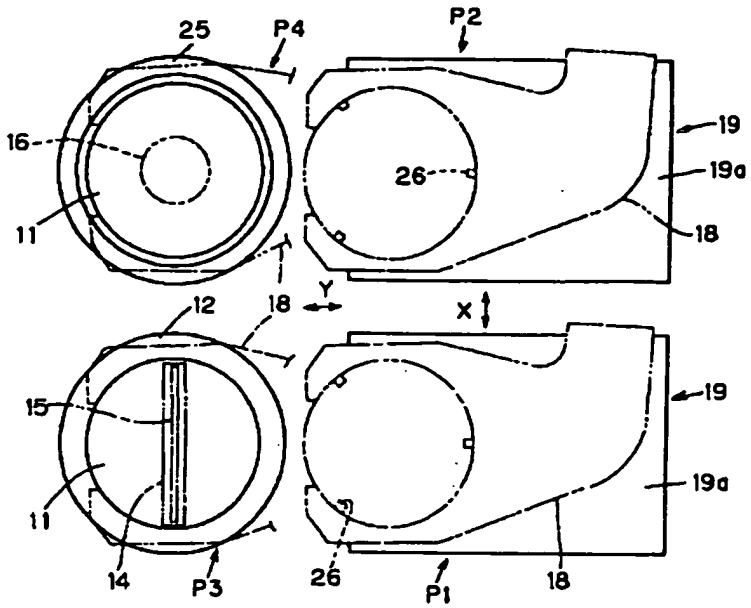
【符号の説明】

１１　円形ウェハ
１２　第１のスピンチャック
１３　第１のモータ
１４　スリットノズル
１５　スリット
１６　第２のスピンチャック
１７　第２のモータ
１８　搬送アーム
１９　搬送ロボット

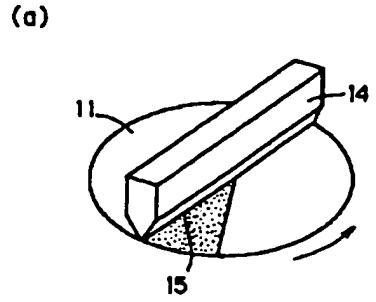
【図１】



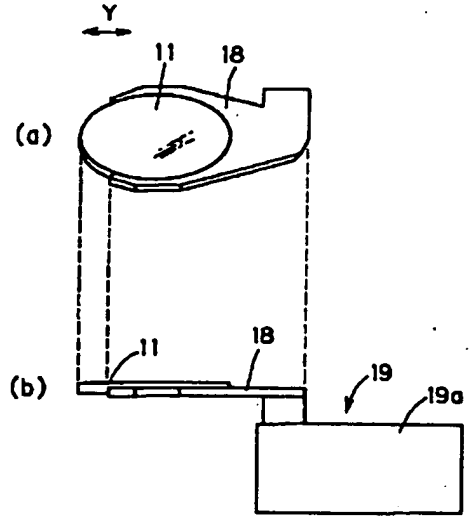
【図2】



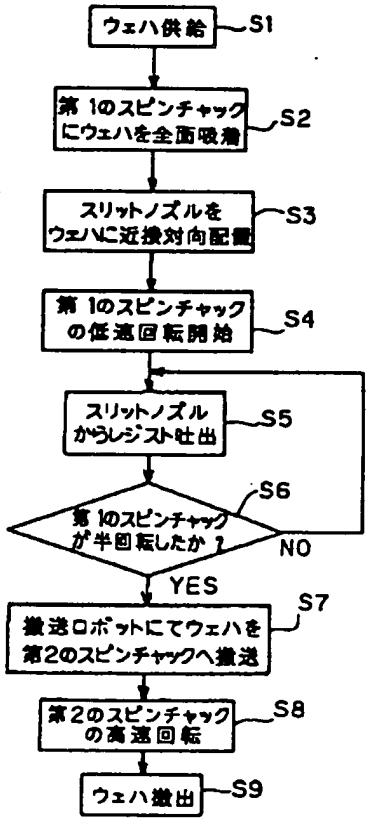
【図3】



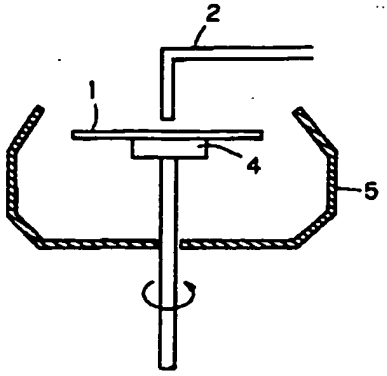
【図4】



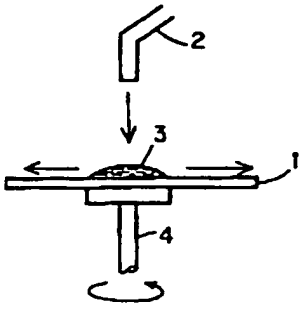
【図5】



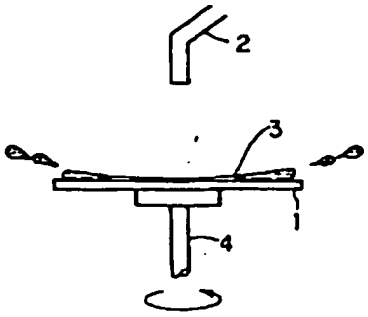
【図6】



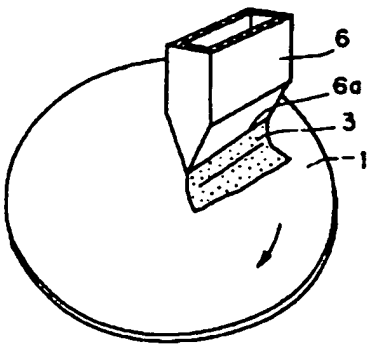
【図7】



【図8】



【図9】



Japanese Kokai Patent Application No. Hei 8[1996]-168715

Translated from Japanese by the Ralph McElroy Co., Custom Division
P.O. Box 4828, Austin, Texas 78765 USA

Code: 1984-65386
Ref. No.: SILI 2-375

JAPANESE PATENT OFFICE

PATENT JOURNAL

KOKAI PATENT APPLICATION NO. HEI 8[1996]-168715

Technical Disclosure Section

Int. Cl.[illegible]: B 05 C 11/08
B 05 D 1/40
H 01 L 21/027
H 01 L 21/30

Sequence Nos. for Office Use: A 7415-4F

Application No.: Hei 6[1994]-313335

Application Date: December 16, 1994

Publication Date: July 2, 1996

No. of Claims: 2 (Total of 8 pages; OL)

Examination Request: Not requested

ROTARY COATING DEVICE AND ROTARY COATING METHOD

Inventor: Masahiro Mimasaka
Dainippon Screen Mfg. Co., Ltd. 322 Hatabashi Furukawa-cho, Fushimi-ku, Kyoto

Applicant: 000207551
Dainippon Screen Mfg. Co., Ltd.
1-1 Metenji Kita-cho, 4-chome, Horikawadori Terashinaiagaru, Kamigyo-ku, Kyoto-shi, Kyoto-fu

Agents: Shigeaki Yoshida, patent attorney, and two others

[There are no amendments to this patent.]

Abstract

Objective

To keep the discharge of a treating solution to an irreducible minimum and to maintain a stable quantity of solution on the substrate.

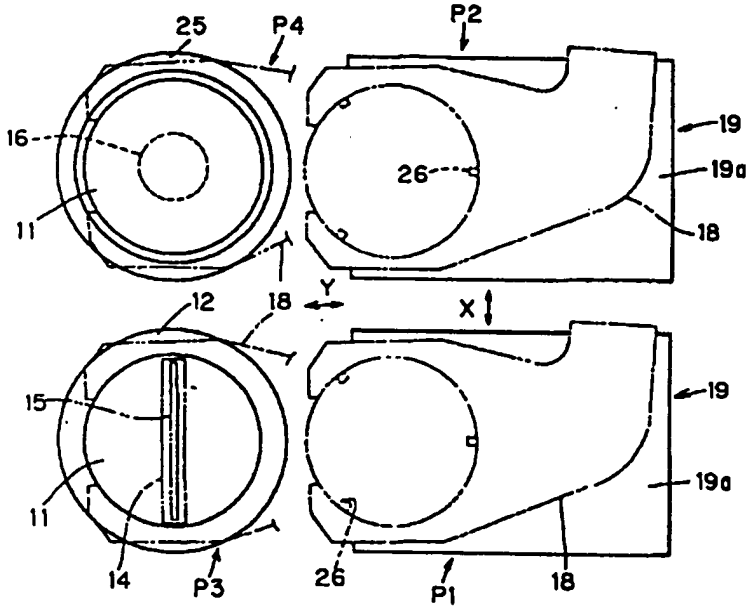
Constitution

The entire surface of round wafer (11) is suctioned and flattened on low-speed rotating chuck (12) and wafer (11) is rotated at a low speed while discharging a treating solution to the wafer front surface from slit nozzle (14) of a length approximately equal to the diameter of wafer (11). Thereafter, wafer (11) is transported to high-speed rotating chuck (16), wafer (11) is rotated at a high speed, and is made into the

necessary film thickness by shaking off the excess treating solution with centrifugal force.

Effect

The treating solution can be fed by placing slit nozzle (14) as close as possible to wafer (11) and the use quantity of treating solution can be decreased.



Claims

1. A rotary coating device provided with,
in a rotary coating device which feeds and coats a treating solution on the front surface of an approximately round substrate by rotating the substrate, a first substrate supporting means which supports the back surface of said substrate by suctioning approximately the entire surface,

a treating solution feeding means which discharges the treating solution with respect to the front surface of said substrate supported by said first substrate supporting means linearly in length approximately equal to the diameter thereof or slightly shorter,

a first rotating means which rotates at least one out of said first substrate supporting means and said treating solution feeding means at a prescribed low speed with respect to the other,

a second substrate supporting means which supports by suctioning only the center part on the back surface of said substrate, a second rotating means which rotates said second substrate supporting means at a prescribed high speed so that the treating solution on said substrate becomes smooth according to centrifugal force, and a transporting means which transports said substrate to said second substrate supporting means from said first substrate supporting means after discharging the treating solution at said treating solution feeding means.

2. A rotary coating method which is provided with, in a rotary coating method which feeds a treating solution to the front surface of an approximately round substrate and coats by rotating the substrate,

a treating solution discharging process which rotates at least one pertinent substrate and said treating solution feeding means at a prescribed low speed with respect to the other while discharging the treating solution to the front surface of the pertinent substrate linearly along the diameter of the pertinent substrate according to a treating solution feeding means in a state of having suctioned approximately the entire back surface of said substrate to the first substrate supporting means, a transporting process which transports said substrate to the second substrate supporting means from said first substrate supporting means after completing the discharge of said treating solution from said treating solution feeding means, and
a high-speed rotating process which rotates said second substrate supporting means at a prescribed high speed so as to smoothen the treating solution on said substrate according to centrifugal force in a state of having suctioned and supported only the center part on the back surface of the substrate with said second substrate supporting means.

Detailed explanation of the invention

[0001]

Industrial application field

This invention relates to a rotary coating device and a rotary coating method of a spin coater, etc. which feeds a photoresist solution, etc., to a semiconductor substrate represented by silicon wafer or a substrate of a dielectric, metal, insulator, etc., and coats by rotating during the fine

pattern formation process in the manufacturing process of an electronic component such as IC, LSI, liquid-crystal display device, etc.

[0002]

Prior art

First conventional example

The rotary coating device in the first conventional example discharges resist solution (3) (photoresist) from nozzle (2) to the center part of wafer (1) supported horizontally as shown in Figure 6 with wafer (1) in the stationary state or in a state of being rotated at a low speed as shown in Figure 7, then coats resist solution (3) on the substrate surface by rotating wafer (1) at a high speed as shown in Figure 8. (4) in Figure 7 and Figure 8 is the rotary support part which rotates by suctioning and fixing the center part of wafer (1), and (5) in Figure 6 is the chamber.

[0003]

Second conventional example

As a rotary coating device of the second conventional example, for example, the resist coating device disclosed in Japanese Kokai Patent Application No. Sho 58[1983]-170565 exists. Figure 9 is a figure explaining the structure of this device. In the rotary coating device of the second conventional example,

round wafer (1) is placed horizontally on a support stand, the center part thereof is suctioned and fixed, and resist solution (3) (photoresist) is dripped in a band shape from nozzle (6) formed with slit-shaped discharge port (6a) on the surface of said wafer (1) while rotating wafer (1) along with the support stand with the center axis (perpendicular axis) as the center. Next, after the dripping of resist solution (3) ends, wafer (1) is rotated along with the support stand at a high speed with the center axis (perpendicular axis) as the center and a thin film is formed by spreading resist solution (3) on the surface of wafer (1) with centrifugal force.

[0004]

Problems to be solved by the invention

Problems in the first conventional example

In the first conventional example, resist solution (3) discharged to the center part of wafer (1) is spread on the entire surface thereof by rotating wafer (1) at a relatively low speed; then, a thin film of resist solution (3) is formed in necessary thickness by rotating wafer (1) at a relatively high speed and shaking off excess resist solution (3). According to this device, it is possible to obtain a coated thin film of relatively favorable uniformity in the film thickness. However, with this device, a relatively large quantity of resist solution (3) has to be fed in order to spread resist solution (3) on the entire surface of wafer (1) according to rotation, resist solution (3) waste is created even in said step of spreading the

coating, and furthermore, excess resist solution (3) is shaken off additionally so the ratio of resist solution (3) utilized effectively becomes very small. In this case, it is necessary to feed resist solution (3) from the nozzle [in a quantity] tens of times more than the resist quantity (resist quantity left on wafer (1) after the high-speed rotation) necessary for coating resist solution (3) in a prescribed thickness (e.g., few μm). Namely, 90% or more of resist solution (3) fed from the nozzle is scattered to the periphery of wafer (1) according to high-speed rotation, so this portion of the material is wasted.

[0005]

Problems in the second conventional example

In the second conventional example, resist solution (3) fed to the surface of wafer (1) is in a state of having already been spread on the entire surface, so waste of resist solution (3) in the step of spreading resist solution (3) on the entire surface of wafer (1) can be made relatively small. Also, in this conventional example, it is preferable to feed resist solution (3) in thickness (e.g., a few tens of μm) as close to the necessary final film thickness as possible in the step for feeding resist solution (3) to wafer (1), in order to further reduce the use quantity of resist solution (3). For this, it is necessary to arrange wafer (1) and slit shape discharge port (6a) of nozzle (6) as close together as possible (e.g., a few tens of μm). In this case, it is necessary to secure flatness of wafer (1) in order to maintain the spacing distance of wafer (1), and for slit-shaped discharge port (6a) of nozzle (6) to be short and

fixed. However, suction and fixation of wafer (1) on the support stand was executed only at the center part in the rotary coating device of the conventional example, so it was difficult to secure flatness of wafer (1) when wafer (1) had warped due to the effect of the heat treatment applied before or due to flexing from dead weight. Specifically, to place nozzle (6) close to a few tens of μm was difficult since said warpage and flexing of wafer (1) reach a maximum of a few hundred μm (e.g., warpage with respect to a wafer with diameter of 8 in is 150 μm). In order to discharge resist solution (3) on wafer (1) evenly under this condition, it is necessary to arrange the discharge quantity of resist solution (3) to be much greater than the minimum necessary quantity and this led to an increase in the material cost.

[0006]

The present invention takes said problems into consideration and aims to provide a rotary coating device and a rotary coating method which can further reduce the necessary quantity of treating solution and in which the film thickness on the substrate is of favorable uniformity.

[0007]

Means to solve the problems

The means for solving the problem related to Claim 1 of the present invention is provided with, in a rotary coating device which feeds and coats a treating solution on the front face of an approximately round substrate by rotating the substrate, a first

substrate supporting means which supports the back surface of said substrate by suctioning approximately the entire face, a treating solution feeding means which discharges the treating solution with respect to the front surface of said substrate supported by said first substrate supporting means linearly in length approximately equal to the diameter thereof or slightly shorter, a first rotating means which rotates at least one out of said first substrate supporting means and said treating solution feeding means at a prescribed low speed with respect to the other, a second substrate supporting means which supports by suctioning only the center part of the back surface of said substrate, a second rotating means which rotates said second substrate supporting means at a prescribed high speed so that the treating solution on said substrate becomes smooth according to centrifugal force, and a transporting means which transports said substrate to said second substrate supporting means from said first substrate supporting means after discharging the treating solution at said treating solution feeding means.

[0008]

The means for solving the problem related to Claim 2 of the present invention is provided with, in a rotary coating method which feeds a treating solution to the front surface of an approximately round substrate and coats by rotating the substrate, a treating solution discharging process which rotates at least one out of a pertinent substrate and said treating solution feeding means at a prescribed low speed with respect to the other while discharging the treating solution to the front surface of the pertinent substrate linearly along the diameter of

the pertinent substrate according to a treating solution feeding means in a state of having suctioned approximately the entire back surface of said substrate to the first substrate supporting means, a transporting process which transports said substrate to the second substrate supporting means from said first substrate supporting means after completing the discharge of said treating solution from said treating solution feeding means, and a high-speed rotating process which rotates said second substrate supporting means at a prescribed high speed so as to smoothen the treating solution on said substrate according to centrifugal force in a state of having suctioned and supported only the center part of the back face of the substrate with said second substrate supporting means.

[0009]

Function

In the rotary coating device related to Claim 1 and rotary coating method related to Claim 2 of the present invention, approximately the entire back surface of the substrate is suctioned with the first substrate support means and rotated at a low speed by supporting the substrate flatly, a treating solution is discharged in this state to the front surface of the substrate from the treating solution feeding means linearly along the diameter thereof, and the treating solution is fed approximately on the entire surface of the substrate. Even if warpage or flexing is generated in the substrate, influence of this warpage and flexing can be reduced and the treating solution feeding means can be placed as close as possible to the substrate.

Consequently, the treating solution is fed to the front surface of the substrate in a relatively thin and uniform state and the discharge quantity of treating the solution is reduced.

[0010]

After feeding the treating solution to the substrate, the substrate is transported to the second substrate supporting means, and when shaking off the treating solution, only the center part of the back surface of the substrate is suctioned and supported to execute high-speed rotation, so the treating solution entering between the substrate supporting means and the substrate according to capillary phenomenon or the substrate supporting means being contaminated by the mist of the treating solution adhering to the substrate supporting means is minimal.

[0011]

Application examples

First application example

Constitution

Figure 1 is a schematic diagram showing the rotary coating device in the first application example of the present invention, and Figure 2 is a top view similarly showing the rotary coating device of this application example. Said rotary coating device forms a thin film of photoresist on the front surface of round wafer (11) by feeding and coating photoresist (treating solution)

on the front surface of rotating semiconductor round wafer (11) as shown in Figures 1 and 2.

[0012]

Here, (12) in Figures 1 and 2 is the first spin chuck (first substrate supporting means: entire surface suctioning state) which supports the back surface by suctioning the entire surface with the front surface of round wafer (11) facing upwards, (13) the first motor (first rotating means) which rotates said first spin chuck (12) at a prescribed low speed around the perpendicular axis, (14) the slit nozzle (14) (treating solution feeding means) which feeds photoresist towards the front surface of round wafer (11) which is rotated at a low speed by being supported by said first spin chuck (12), (15) the slit-shaped treating solution discharge port (hereafter referred to simply as slit) formed to the bottom surface of said slit nozzle (14), (16) the second spin chuck (second substrate supporting means: spin treatment part) which is arranged at a parallel at the side of first spin chuck (12) and supports by suctioning only the center part of said round wafer (11), (17) the second motor (17) (second rotating means) which rotates said second spin chuck (16) at a prescribed high speed around the perpendicular axis, and (18) the transport arm of transport robot (19) (transporting means) which transports said round wafer (11) to said second spin chuck (16) from said first spin chuck (12) after the discharging of treating solution at said slit nozzle (14).

[0013]

As said first spin chuck (12), one of entire surface vacuum suctioning mode, which is made to be a larger diameter than round wafer (11), is used in order to secure flatness in favorable precision and prevent warpage and flexing of round wafer (11) to be supported. Here, approximately the entire back surface of round wafer (11) is directly contacted to first spin chuck (12) in the case of said chuck of entire surface vacuum suctioning, so even if first spin chuck (12) is used for high-speed rotation, there is a concern over the spin chuck itself being contaminated by the mist of the treating solution adhering to spin chuck (12) or entering between the wafer back surface and the chuck top surface by capillary action, etc., or said mist adhering to the entire back surface of round wafer (11) and contaminating thereof when shaking off the treating solution during high-speed rotation. This situation is not favorable for quality control. Therefore, said first spin chuck (12) is restricted to being used only when discharging the treating solution from said slit nozzle (14) (during low-speed rotation).

[0014]

During the transport of said round wafer (11), it is necessary to execute the transport by inserting said transport arm (18) on the back surface of said round wafer and supporting thereof, but said first spin chuck (12) closely contacts and covers the entire back surface part of said round wafer (11) so it is not possible to insert transport arm (18) to the back surface of said round wafer (11) in this state. Namely, in order

to insert transport arm (18) to the back surface of said round wafer (11), it is necessary to separate the back surface of round wafer (11) from said first spin chuck (12) by raising round wafer (11) upwards. Therefore, wafer ascending device (22) which raises round wafer (11) from the top surface of first spin chuck (12) is provided as shown in Figure 1. Namely, through-holes (20) are formed at multiple spots (not less than 3 spots) in the wafer support area of first spin chuck (12), and furthermore, support rods (21) of said wafer ascending device (22) are inserted into said through-holes (20) (refer to the dotted line in Figure 1) to support said round wafer (11) and to raise said round wafer (11). Said wafer ascending device (22) is provided with, for example, motor, pinion, rack, etc., (not shown in the figure) and is driven and controlled in connection with the operation of said transport arm (18).

[0015]

Said first motor (13) rotates said first spin chuck (12) at a low speed with respect to said slit nozzle (14) with the perpendicular axis as the center when discharging treating solution from said slit nozzle (14) as shown in Figure 1 and the rotating speed is about 10-50 rpm, preferably about 20-30 rpm.

[0016]

Said slit nozzle (14) is supported to be able to elevate in a horizontal posture according to a prescribed support not shown in the figure. The length of slit (15) in said slit nozzle (14) (hereafter referred to as nozzle length) is set to be

approximately equal to the diameter of round wafer (11) which becomes the treatment target as shown in Figure 3(a). Said slit nozzle (14) is arranged so that the center of slit (15) thereof is positioned above the rotation center of round wafer (11) supported by first spin chuck (12), and by discharging photoresist linearly to the area approximately corresponding to the diameter of round wafer (11) while being rotated at a low speed by said first motor (13), photoresist is discharged approximately on the entire surface area of round wafer (11). However, in actuality, it is preferable for the nozzle length to be arranged slightly shorter than the diameter of pertinent round wafer (11). The reason for making the nozzle length slightly shorter than the diameter is that it is not necessary to coat the circumferential edge part of round wafer (11) with resist, so by doing so, the transporting means of round wafer (11) being contaminated with resist can be prevented. Also, by said slit nozzle (14) being lowered and arranged at a position of prescribed height with respect to said first spin chuck (12) as shown in Figure 1, the spacing distance (δ) between the front surface of round wafer (11) and slit (15) of said slit nozzle (14) is set at, for example, about 30-100 μm. By it, feeding of the photoresist to round wafer (11) from slit nozzle (14) is executed so as to target the thickness of the photoresist after the feeding to be approximately equal (about 30-100 μm) to said spacing distance (δ). Consequently, the necessary collective feeding quantity of the photoresist is about 1-3 mL in the case of 8-in diameter round wafer (11).

[0017]

Rotation of said first spin chuck (12) is for scanning slit (15) of slit nozzle (14) on approximately the entire surface of round wafer (11) and for feeding by spreading the photoresist on approximately the entire surface of round wafer (11), and the rotational frequency thereof is set at a low speed to an extent of the fed photoresist not flowing out to the outside from the edge of round wafer (11) by centrifugal force.

[0018]

Said second spin chuck (16) is rotated at a high-speed rotation with the objective of shaking off the treating solution, and the contact area with round wafer (11) is arranged to be as small as possible so as to reduce the state of the mist of the treating solution entering between the wafer back surface and the chuck top surface by capillary action, etc., when shaking off the treating solution. Namely, said second spin chuck (16) is composed to suction and support round wafer (11) only at the center part as shown in Figures 1 and 2. Said second spin chuck (16) is accommodated within draining chamber (25) for discharging the drainage when shaking off the treating solution.

[0019]

Said second motor (17) is for leveling or smoothing the film thickness of the treating solution to the necessary dimension (the target dimension is, for example, about 1 μm) by rotating at a high speed with the perpendicular axis as the center and

shaking off the treating solution discharged to the front surface of said round wafer (11) by centrifugal force as shown in Figure 1, and the rotating speed is, for example, about 2000-6000 rpm, preferably, about 3000-5000 rpm.

[0020]

Though not shown in the figure, intake passage for suctioning and supporting round wafer (11) is formed in first spin chuck (12) and second spin chuck (16).

[0021]

Said transport robot (19) is composed by attaching transport arm (18) to base part (19a) thereof as shown in Figure 4. Base part (19a) has a drive mechanism which advances and retreats transport arm (18), and transport arm (18) is attached to base part (19a) such that it is able to advance and retreat in the horizontal (Y) direction. Also, base part (19a) has a moving mechanism capable of being moved in the (X) direction which crosses the (Y) direction within the horizontal plane and is provided to move along first spin chuck (12) and second spin chuck (16) as shown in Figure 2. By this, transport arm (18) can move in the vertical (X) direction which connects transport position (P1) adjacent to said first spin chuck (12) and transport position (P2) adjacent to said second spin chuck (16) as shown as a top view in Figure 2, and moreover, can move in the horizontal (Y) direction which connects transport position (P1) and receiving position (P3) and transport position (P2) and receiving position (P4). Transport robot (19) executes

feeding/transporting operation by transporting round wafer (11) between first spin chuck (12), second spin chuck (16), and heat treatment part such as the hot plate, cool plate, etc., not shown in the figures or wafer feed part (indexer) and other treatment parts, etc., according to said movement. (26) in Figure 2 is the support claw for mounting and supporting said round wafer (11) in said transport arm (18).

[0022]

Operation

The operation of the rotary coating device with the aforementioned constitution and the method in the present invention which uses the device thereof will be explained according to Figure 5. First of all, round wafer (11) is fed to said first spin chuck (12) (entire surface suctioning stage) from said treatment part not shown in the figure such as heat treatment, etc., with transport robot (19) (step S1). Then, the entire back surface of round wafer (11) is vacuumed and suctioned to first spin chuck (12) to correct the warpage or flexing of round wafer (11) (step S2) and slit nozzle (14) which approximately covers the diameter of round wafer (11) is placed closely by opposing the front surface of round wafer (11) (step S3). At this time, the spacing distance (δ) between the nozzle and round wafer (11) is set to be as small as about 30-100 μm as shown in Figure 1.

[0023]

Next, round wafer (11) is rotated at a slow speed (step S4), photoresist is discharged linearly along the diameter of round wafer (11) from slit nozzle (14) (treating solution discharge process: step S5), and photoresist is coated on approximately the entire front surface of round wafer (11). The rotating speed at this time is about 10-50 rpm, preferably about 20-30 rpm. Spacing distance (δ) between the nozzle and round wafer (11) is arranged to be small at about 30-100 μm at this time so the treating solution can be coated thinly at about 30-100 μm and can greatly reduce the coating unevenness. The nozzle length of slit nozzle (14) is arranged to be slightly shorter than the diameter, so resist being coated at the circumferential edge part of round wafer (11) can be prevented and transport arm (18) of transport robot (19) and round wafer (11) being contaminated by the resist can be prevented. Here, the photoresist is discharged linearly along the diameter of round wafer (11) so the resist can be coated on the entire surface of round wafer (11) if round wafer (11) is half-rotated while discharging the photoresist (step S6). Discharge of the photoresist and rotation are stopped when round wafer (11) has been half-rotated. In this step, uniformity in the thickness of the coated photoresist is not that necessary.

[0024]

By thus securing flatness in round wafer (11) by suctioning and supporting the entire surface of round wafer (11) with first spin chuck (12), it is possible to place the slit of the nozzle and round wafer (11) as close as possible (a few tens of μm) and

can maintain a stable quantity of solution on the wafer to a thickness of a few μm while reducing the discharge quantity of photoresist as much as possible.

[0025]

Thereafter, slit nozzle (14) is evacuated by being raised, round wafer (11) is shifted to second spin chuck (16) (spin treatment part) arranged at a parallel to first spin chuck (12) with transport robot (19) (transporting process: step S7) and a resist film of necessary thickness and uniform film thickness is obtained by rotating at a high speed (high-speed rotation process: step S8). The rotating speed is about 2000-6000 rpm, preferably about 3000-5000 rpm. Here, a resist film of superior film thickness uniformity of about a few μm is formed by executing high-speed rotation. Thereafter, round wafer (11) of posttreatment is transported out towards the treatment part of the afterprocess with transport robot (19).

[0026]

As noted above, round wafer (11) is supported very flatly according to entire surface suctioning during the low-speed rotation, so slit nozzle (14) can be placed as close as possible to the front surface of round wafer (11). Therefore, even if the discharge quantity of the treating solution from slit nozzle (14) is set at a minimum, the entire front surface part of round wafer (11) can be coated with the treating solution without unevenness.

[0027]

Also, first spin chuck (12) for entire surface suctioning is used only during the low-speed rotation and is suctioned with second spin chuck (16) only at the center part during the high-speed rotation, so it is possible to decrease the state of the mist of the treating solution entering between the chuck top surface and back surface of round wafer (11) according to capillary action, etc., by making the contact area of the wafer and the chuck small when shaking off the treating solution.

[0028]

It is possible to use that which discharges the treating solution linearly in length approximately equal to or slightly shorter than the radius of the substrate as the slit nozzle. In such case, the slit nozzle is arranged so as to discharge the treating solution along the radius from the center of the substrate as shown in Figure 3(b); then, the substrate is transported to the second substrate supporting means after discharging the treating solution and the shaking off operation of the excess treating solution is executed by rotating at a high speed. Even with this constitution, the use quantity of the treating solution can be reduced and contamination of the substrate and the substrate supporting means can be prevented. However, in this case, it is necessary to rotate the substrate and the slit nozzle once relative to one another in order to feed the treating solution from the slit nozzle to the entire surface of the substrate; a relatively long time is necessary in the feeding of the treating solution; a difference is created in the

volatile state of the solvent component in the treating solution between the treating solution which was discharged initially and the treating solution discharged at the end; thus, the film thickness may not be even after shaking off the excess treating solution by rotating at a high speed. On the contrary, in the case of Figure 3(a) in which feeding of the treating solution can be executed in half-rotation, feeding of the treating solution is completed in a relatively short time, so said inconvenience is not created.

[0029]

Modified example

(1) In the aforementioned application example, a case when a round wafer was targeted as the substrate was explained, but this invention is not restricted to it and can be an approximately round substrate such as a semiconductor wafer, etc., formed with, for example, orientation flat or notch. For example, in the case of a semiconductor wafer formed with orientation flat, it is preferable for slit (15) of slit nozzle (14) to be made so that the size of slit (15) thereof is small and the discharged photoresist is not applied to the orientation flat. This is to prevent the photoresist from adhering on first spin chuck (12), etc. Also, as the treating solution feeding means, it is not restricted to those which use a slit as in the aforementioned application example and can be one that essentially discharges the photoresist linearly along the diameter of the substrate by, for example, arranging many small treating solution discharge ports linearly.

[0030]

(2) In the aforementioned application example, only first spin chuck (12) was rotated by fixing slit nozzle (14), but it is possible to rotate only slit nozzle (14) by fixing first spin chuck (12), and furthermore, it is possible to rotate both first spin chuck (12) and slit nozzle (14) so as to be in mutually opposite directions.

[0031]

Effect of the invention

According to Claims 1 and 2 of the present invention, it is composed such that the substrate is supported flatly by suctioning the entire surface during the low-speed rotation and that the treating solution is discharged from the treating solution feeding means in said state, so even if warpage or flexing is generated in the substrate, it is possible to place the treating solution feeding means as close as possible to the front surface of the substrate after flattening the substrate by suctioning the entire surface. Therefore, discharge of the solution can be executed without waste, the discharge quantity of the treating solution from the treating solution feeding means can be reduced, and the treating solution can be coated evenly on the entire front surface of the substrate.

[0032]

Also, it [the invention] is composed to use the first substrate supporting means for entire surface suctioning only during the low-speed rotation and to suction with the second substrate supporting means only at the center part during the high-speed rotation, so it is possible to make the contact area of the substrate and the substrate supporting means small when shaking off the treating solution, a state of the mist of the treating solution entering between the substrate supporting means top surface and the back surface of the substrate according to capillary action, etc., can be reduced, and contamination of the substrate supporting means and the substrate can be prevented

Brief description of the figures

Figure 1 is a schematic diagram showing the rotary coating device in the first application example of the present invention.

Figure 2 is a top view showing the rotary coating device of the first application example of the present invention.

Figure 3 is a perspective view showing the round wafer and the slit nozzle in the rotary coating device.

Figure 4 is a figure showing the transport robot in the rotary coating device of the first application example of the present invention.

Figure 5 is a flow chart showing the operation of the rotary coating device in the first application example of the present invention.

Figure 6 is a sectional figure schematically showing the rotary coating device in the first conventional example.

Figure 7 is a figure showing the treating solution discharge operation in the rotary coating device of the first conventional example.

Figure 8 is a figure showing the treating solution spreading operation in the rotary coating device of the first conventional example.

Figure 9 is a figure schematically showing the rotary coating device in the second conventional example.

Explanation of symbols

(11)...round wafer, (12)...first spin chuck, (13)...first motor, (14)...slit nozzle, (15)...slit, (16)...second spin chuck, (17)...second motor, (18)...transport arm, (19)...transport robot.

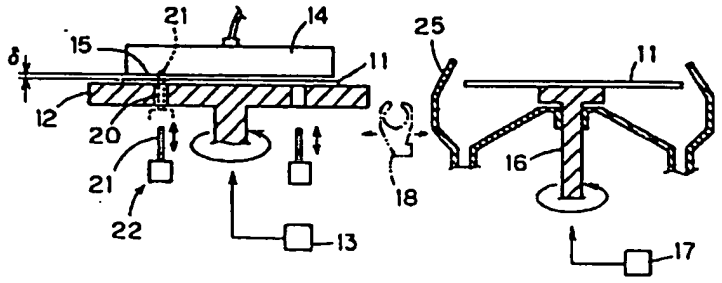


Figure 1

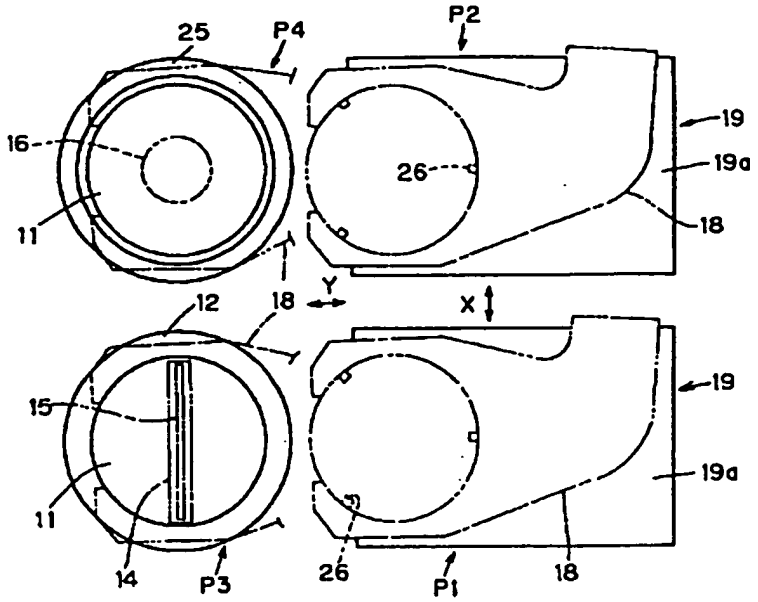
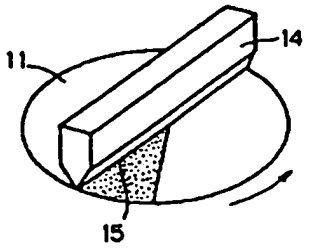


Figure 2

(a)



(b)

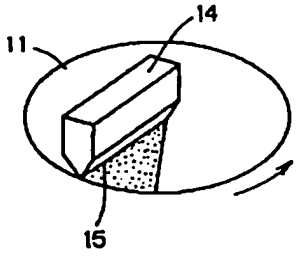


Figure 3

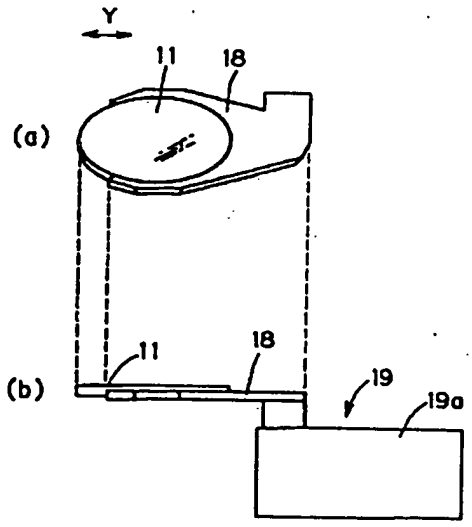


Figure 4

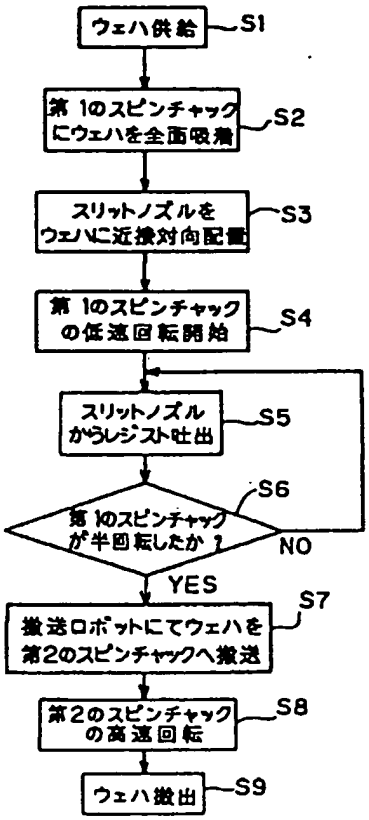


Figure 5

Key: S1) Feed wafer
S2) Suction the entire surface of the wafer to first spin chuck
S3) Arrange slit nozzle to closely oppose wafer
S4) Start low-speed rotation of first spin chuck
S5) Discharge resist from slit nozzle
S6) Has the first spin chuck half-rotated?
S7) Transport the wafer to the second spin chuck with carrier robot

S8) High-speed rotation of second spin chuck
S9) Transport wafer out

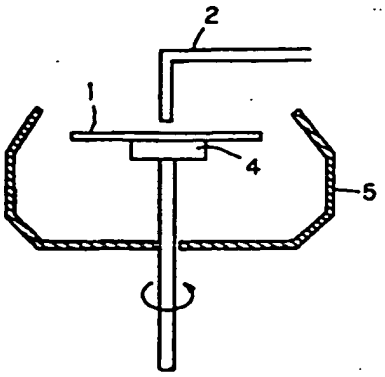


Figure 6

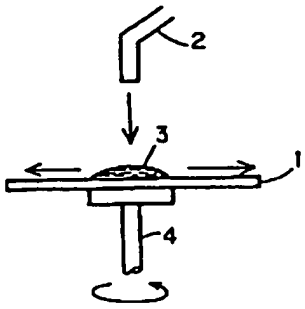


Figure 7

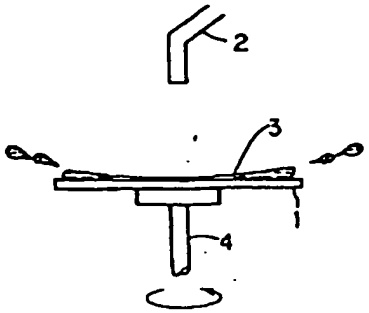


Figure 8

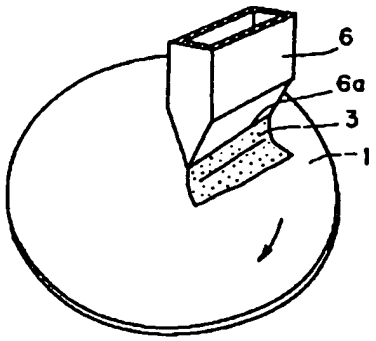


Figure 9